The state of the s

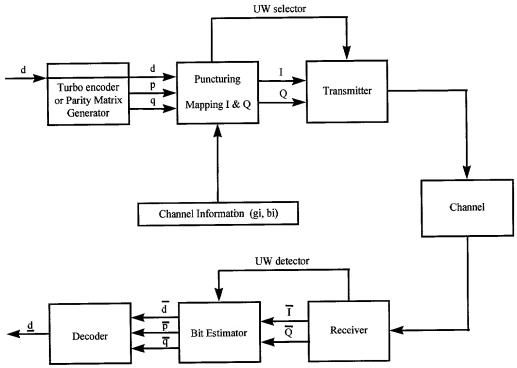


Figure 1

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT.. Attorney: Ronald Coslick - 042159 0119 Foley & Lardner - (310) 277-2223 Sheet 2 of 73

#### BER for Rate 1/2 16QAM, N=512 and N=32768 bits, AWGN Channel

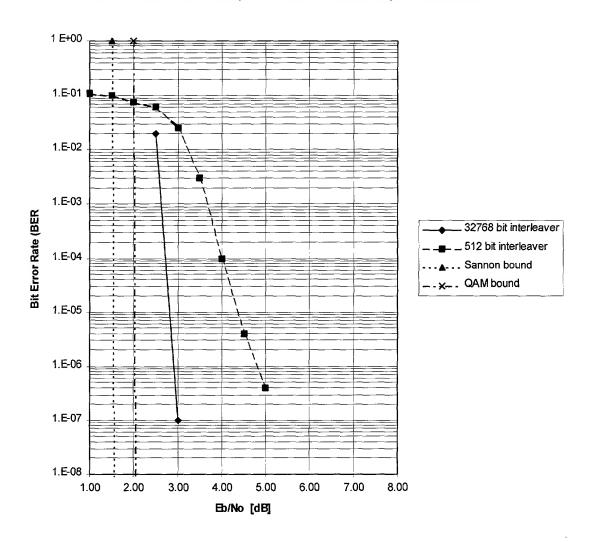


Figure 2

Fig. 1. The first of the first state of the first s

Charles auto, and a spirit of the state of t

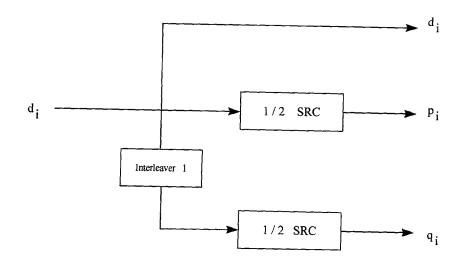


Figure 3

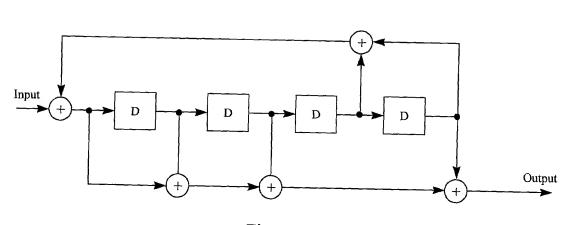


Figure 4

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT Attorney: Ronald Coslick - 042159 0119 Foley & Lardner - (310) 277-2223 Sheet 4 of 73

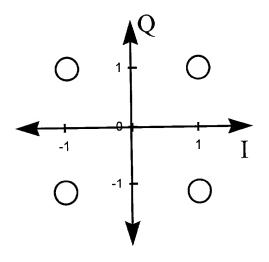


Figure 5

$$\begin{array}{c|c}
[d_0] = [0] & [1] \\
 \hline
 -1 & 1 \\
 A_0 & A_1
\end{array}$$

Figure 6

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT .. Attorney: Ronald Coslick - 042159 0119

Foley & Lardner - (310) 277-2223

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# BER for Rate 2/6 4QAM N=1,024 bits AWGN Channel

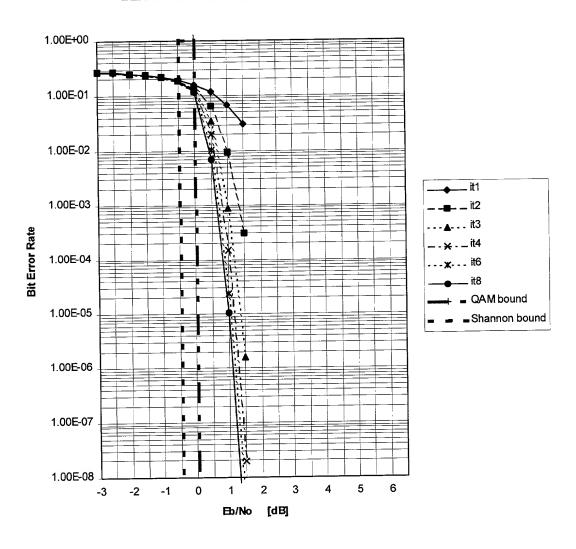


Figure 7

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT Attorney: Ronald Coslick - 042159 0119 Foley & Lardner - (310) 277-2223 Sheet 6 of 73

### BER for Rate 2/4 4QAM N=1,024 bits AWGN Channel

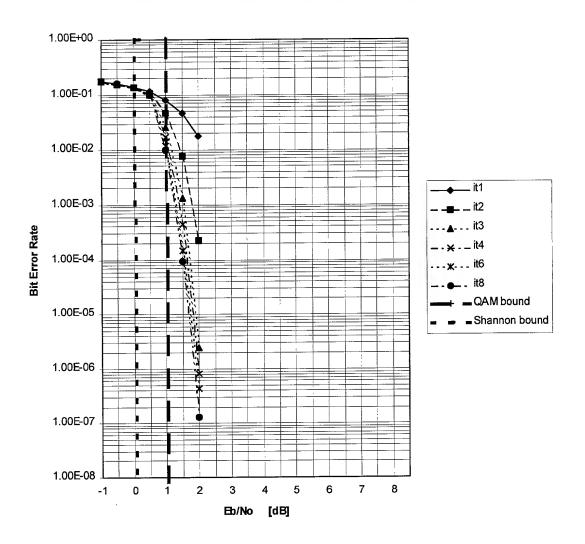


Figure 8

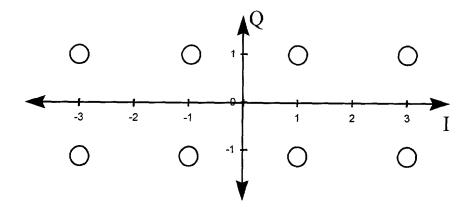


Figure 9

Figure 10

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT... Attorney: Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223 Sheet 8 of 73

#### BER for Rate 1/3 8QAM N=1,024 bits AWGN Channel

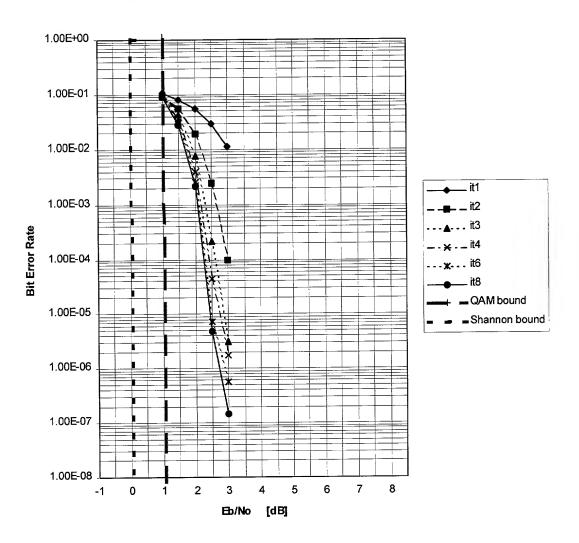


Figure 11

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT .. Attorney: Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223 Sheet 9 of 73

## BER for Rate 4/6 8QAM N=1,024 bits AWGN Channel

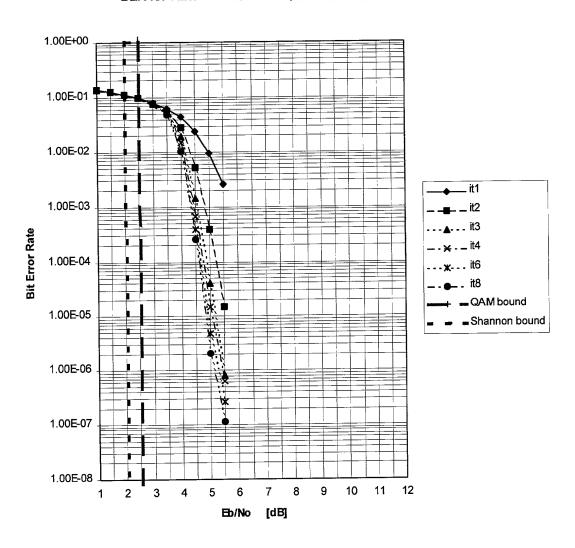


Figure 12

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT... Attomey: Ronald Coshck - 042159 0119 Foley & Lardner - (310) 277-2223

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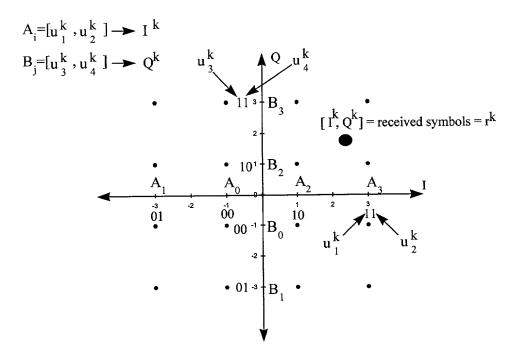


Figure 13

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT. Attorney Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223 Sheet 11 of 73

## BER for Rate 1/2 16QAM, N=272 bits (odd-even), AWGN Channel

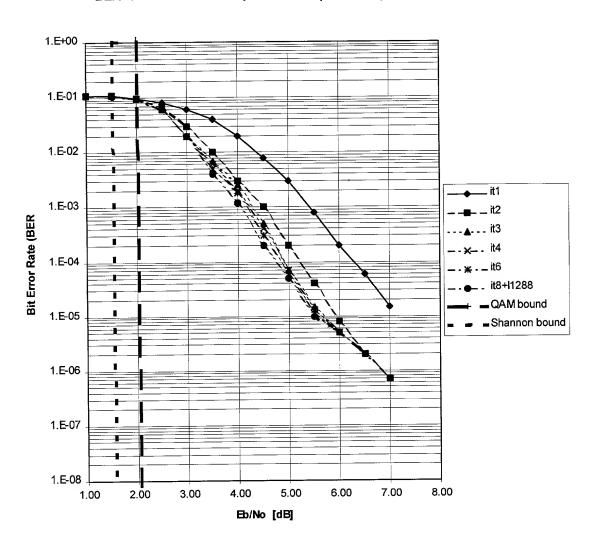


Figure 14

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT... Attorney. Ronald Coslick - 042159 0119 Foley & Lardner - (310) 277-2223 Sheet 12 of 73

# BER for Rate 1/2 16QAM, N=256 bits S-type, AWGN Channel

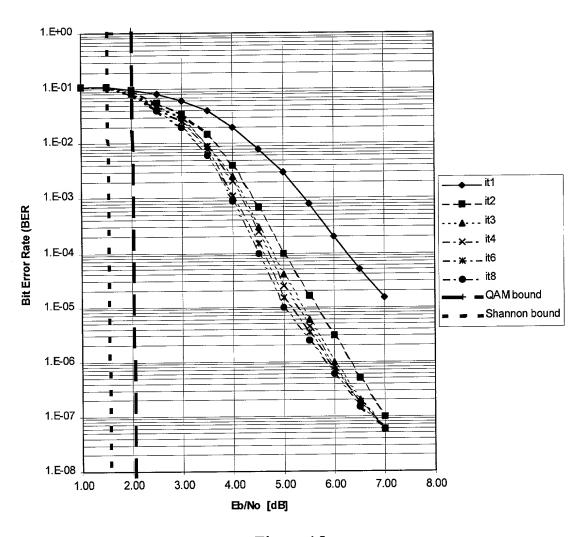


Figure 15

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT . Attorney: Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223

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### BER for Rate 1/2 16QAM, N=512 bits S-type, AWGN Channel

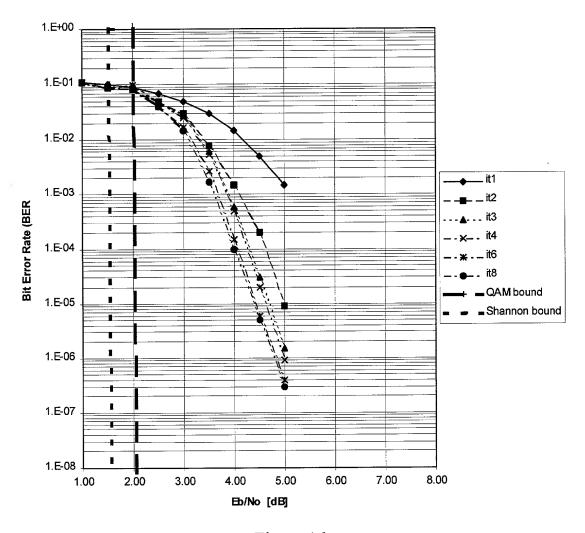


Figure 16

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT Attorney: Ronald Coslick - 042159 0119 Foley & Lardner - (310) 277-2223 Sheet 14 of 73

## BER for Rate 1/2 16QAM, N=768 bits S-type, AWGN Channel

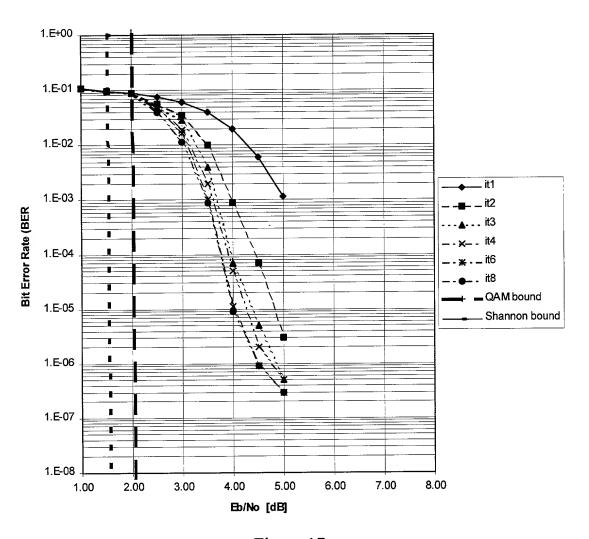


Figure 17

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT... Attorney Ronald Coslick - 042159 0119 Foley & Lardner - (310) 277-2223 Sheet 15 of 73

#### BER for Rate 1/2 16QAM, N=1024 bits S-type, AWGN Channel

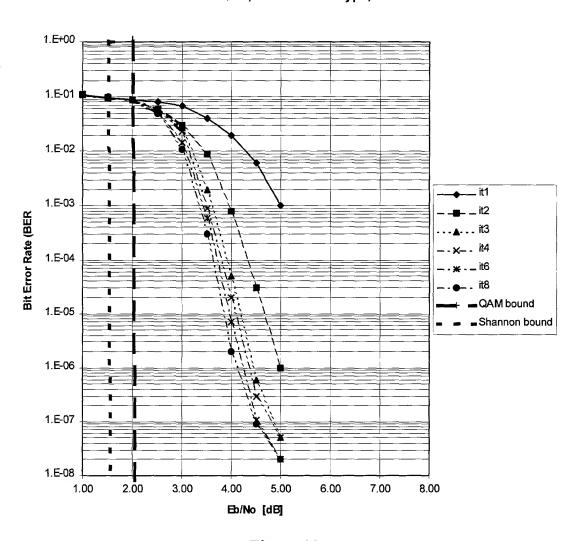


Figure 18

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT... Attorney: Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223

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#### BER for Rate 3/4 16QAM, N=6,144 bits S-type, AWGN Channel

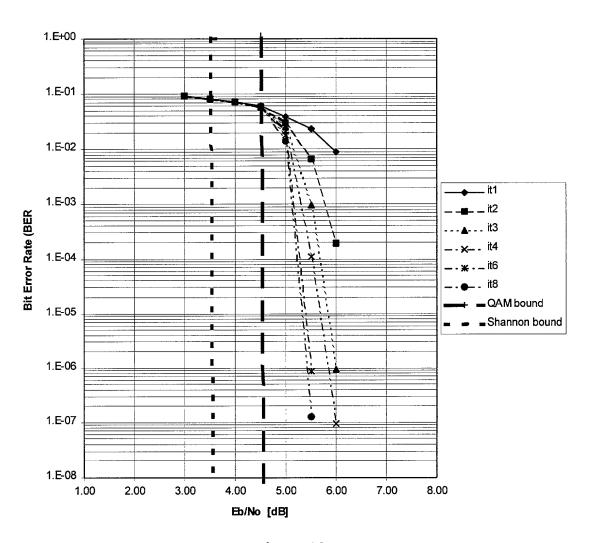


Figure 19

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT... Attorney: Ronald Coslick - 042159 0119 Foley & Lardner - (310) 277-2223

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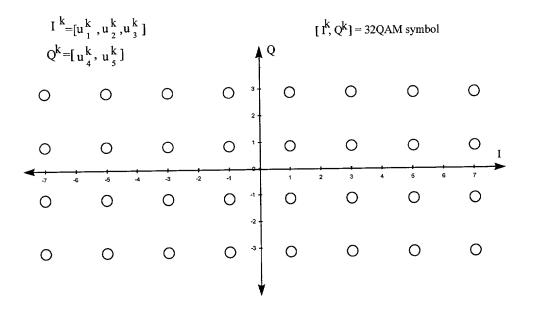


Figure 20

$$E[|a\ 2\ |] = (1+9+25+49)/4 = 21$$

Figure 21

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT . Attorney: Ronald Coslick - 042159 0119 Foley & Lardner - (310) 277-2223

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## BER for Rate 3/5 32QAM, N=6,144 bits S-type, AWGN Channel

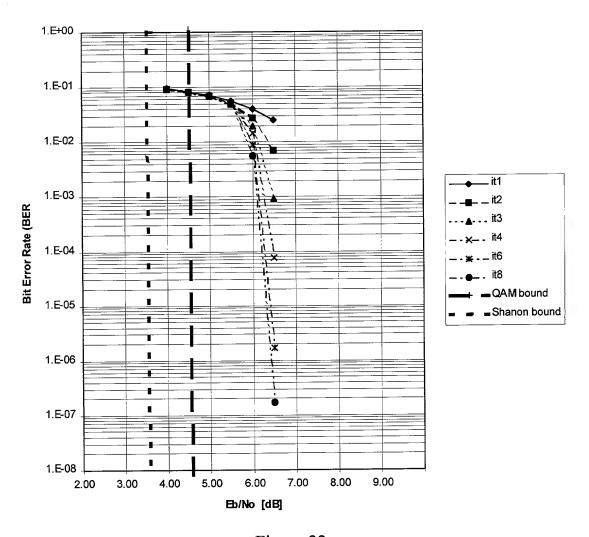


Figure 22

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT. . Attorney. Ronald Coslick - 042159 0119 Foley & Lardner - (310) 277-2223 Sheet 19 of 73

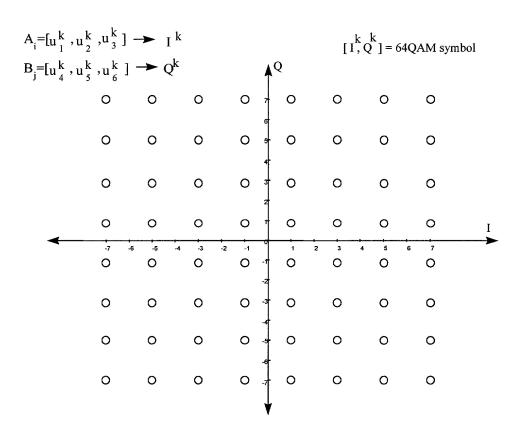


Figure 23

U.S Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT... Attorney Ronald Coslick - 042159 0119 Foley & Lardner - (310) 277-2223 Sheet 20 of 73

### BER for Rate 3/6 64QAM, N=6,144 bits S-type, AWGN Channel

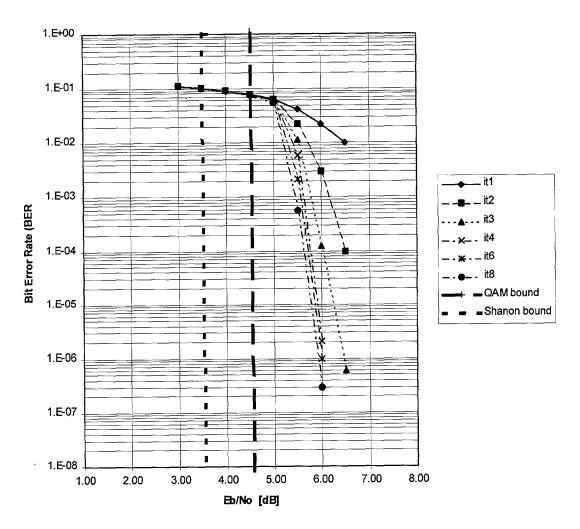


Figure 24

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT .. Attorney. Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223 Sheet 21 of 73

#### BER for Rate 4/6 64QAM N=4,096 bits AWGN Channel, Gray Mapping

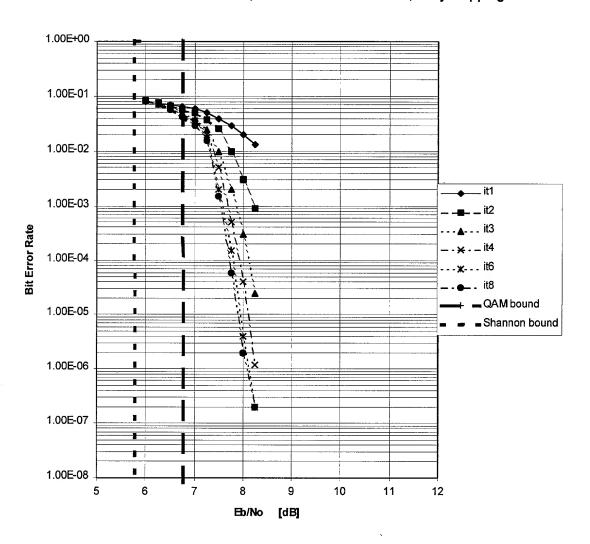


Figure 25

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT... Attorney: Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223 Sheet 22 of 73

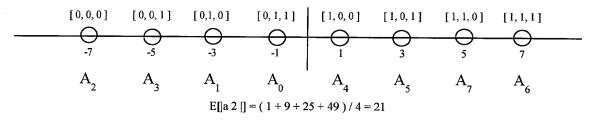


Figure 26

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT .. Attomey: Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223 Sheet 23 of 73

BER for Rate 4/6 64QAM N=4,096 bits AWGN Channel , Natural

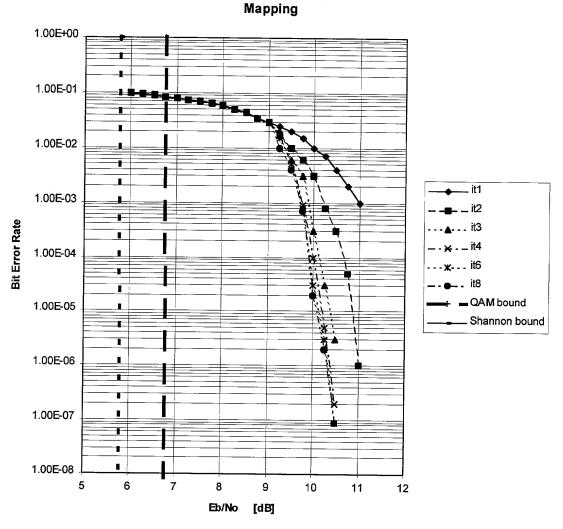


Figure 27

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT... Attorney: Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223 Sheet 24 of 73

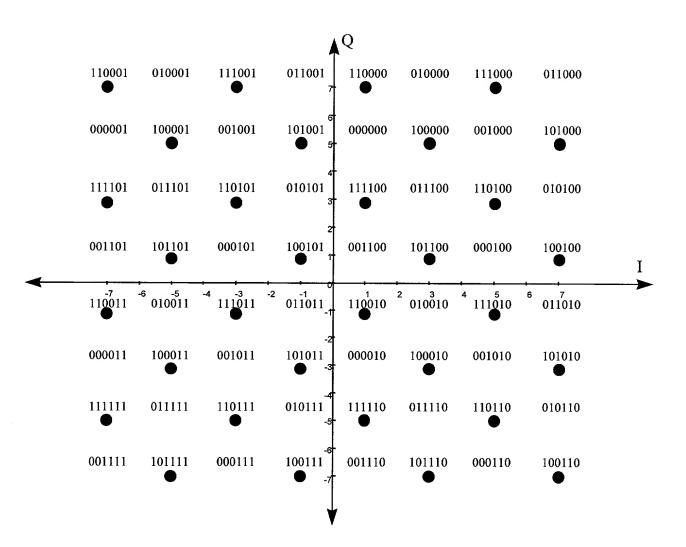


Figure 28

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT... Attorney: Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223 Sheet 25 of 73

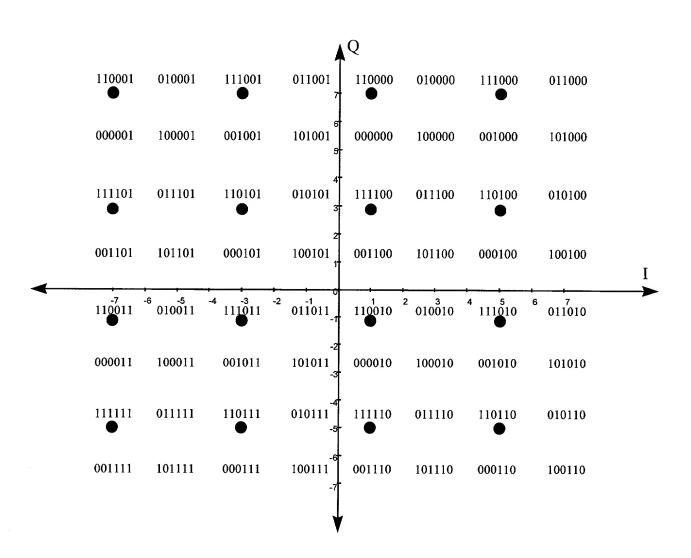


Figure 29

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT... Attomey: Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223

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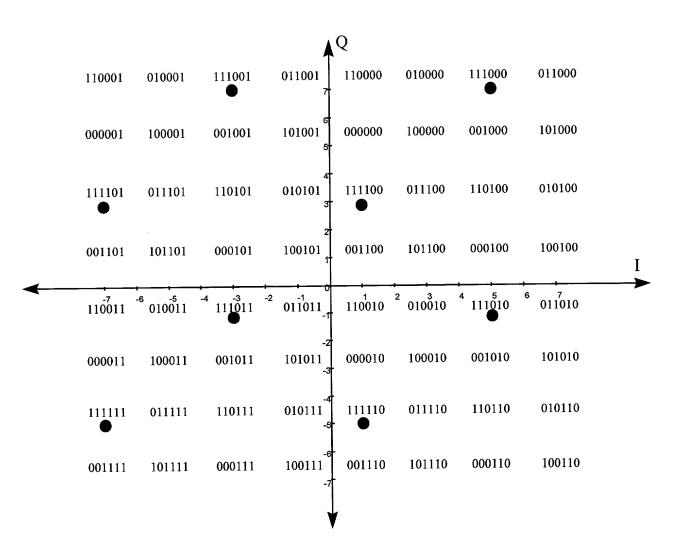


Figure 30

U.S. Express Mail No. EL.639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT... Attorney: Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223 Sheet 27 of 73

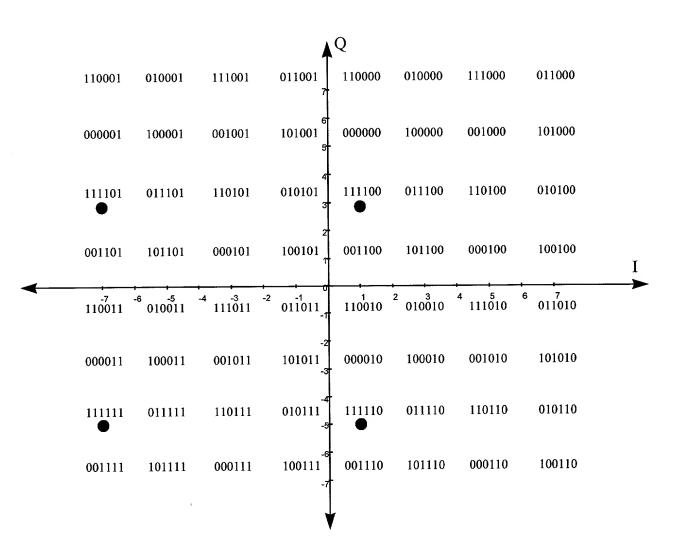


Figure 31

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT.. Attomey: Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223

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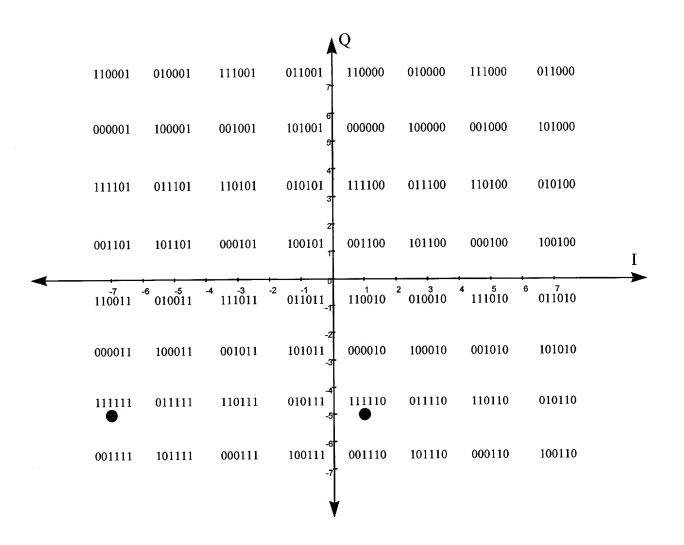


Figure 32

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT. . Attorney Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223 Sheet 29 of 73

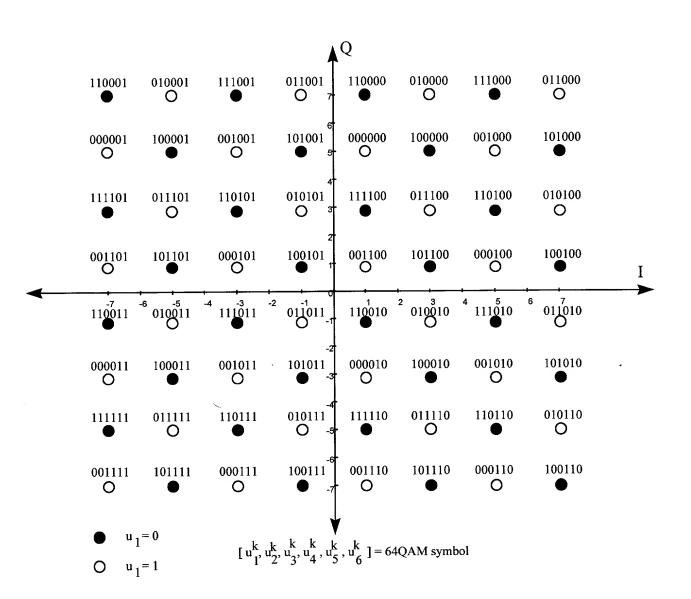


Figure 33

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT... Attorney: Ronald Coshek - 042159.0119 Foley & Lardner - (310) 277-2223 Sheet 30 of 73

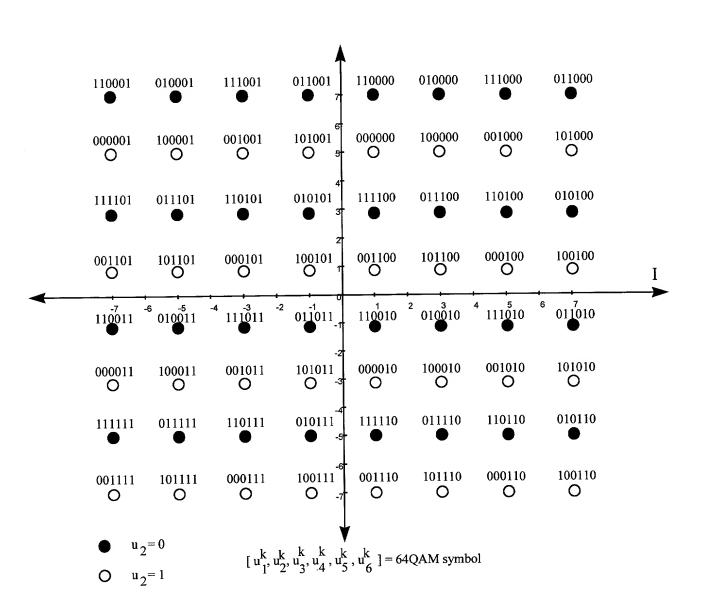


Figure 34

U.S. Express Mail No EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT .. Attorney Ronald Coslick - 042159 0119 Foley & Lardner - (310) 277-2223 Sheet 31 of 73

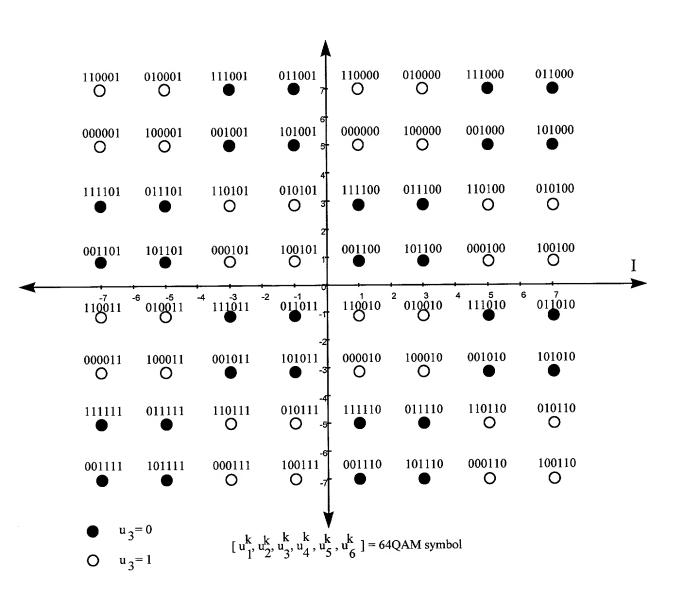


Figure 35

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT.. Attorney: Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223

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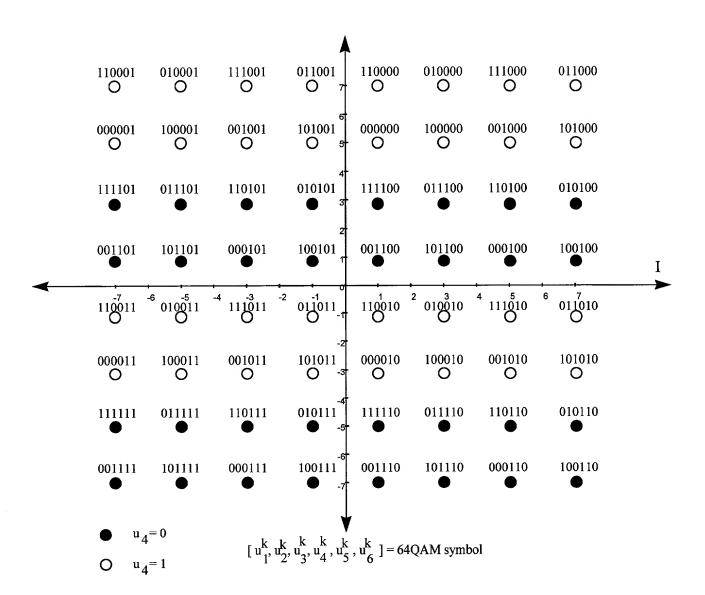


Figure 36

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT Attorney: Ronald Coslick - 042159 0119 Foley & Lardner - (310) 277-2223 Sheet 33 of 73

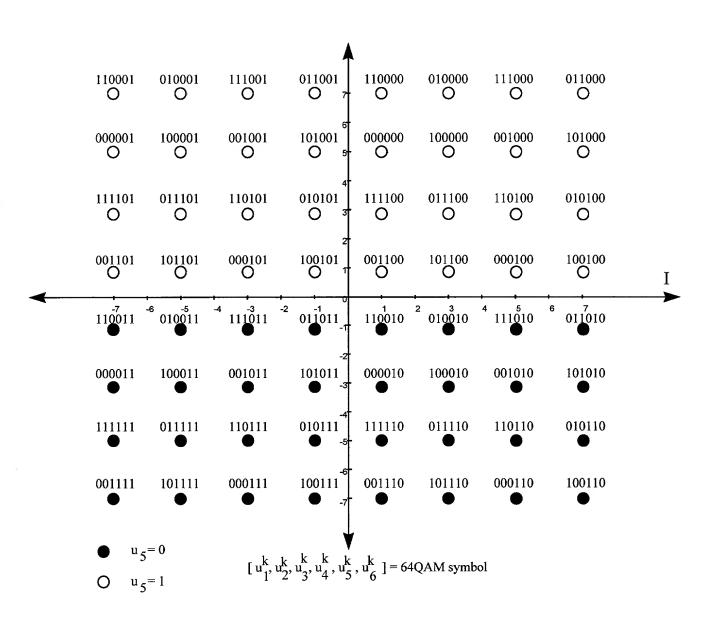


Figure 37

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT... Attorney: Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223 Sheet 34 of 73

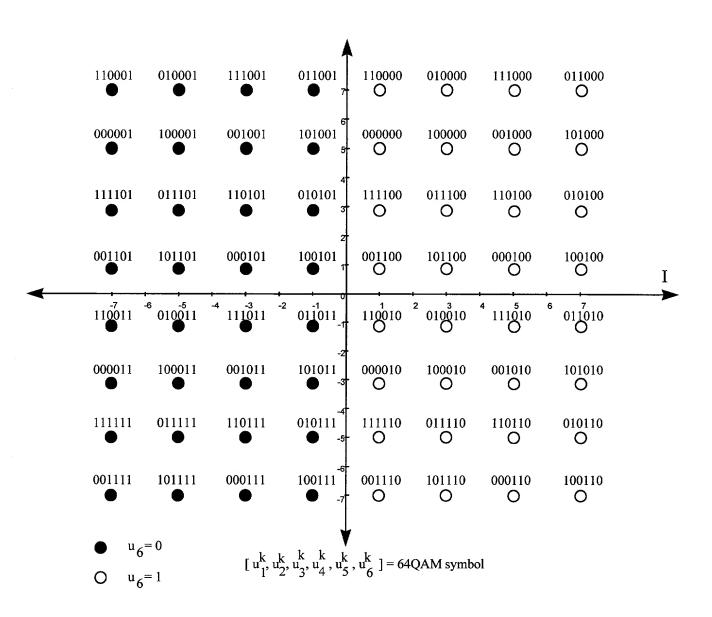


Figure 38

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT Attorney: Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223 Sheet 35 of 73

#### BER for Rate 4/6 64QAM N=4,096 bits AWGN Channel

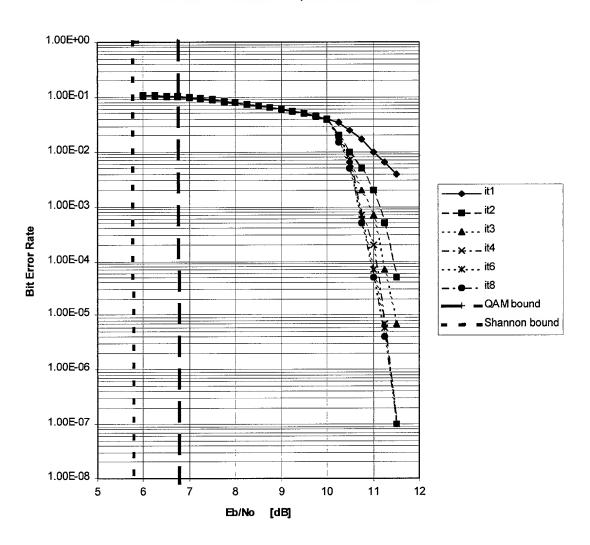
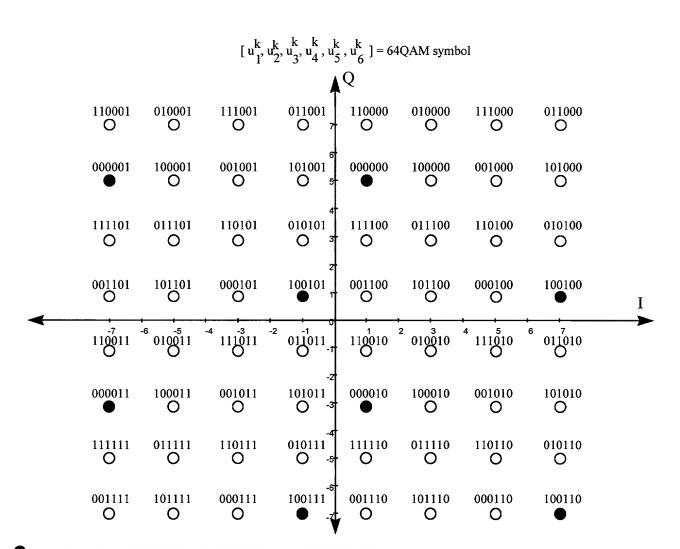


Figure 39

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT... Attorney: Ronald Coslick - 042159 0119 Foley & Lardner - (310) 277-2223

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- This 4 point constellation is selected by the four coded bits 0000
- Each of the four points of the 1001 constellation is selected by two uncoded bits using Gray mapping

Figure 40

U.S Express Mail No EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT . Attorney: Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223

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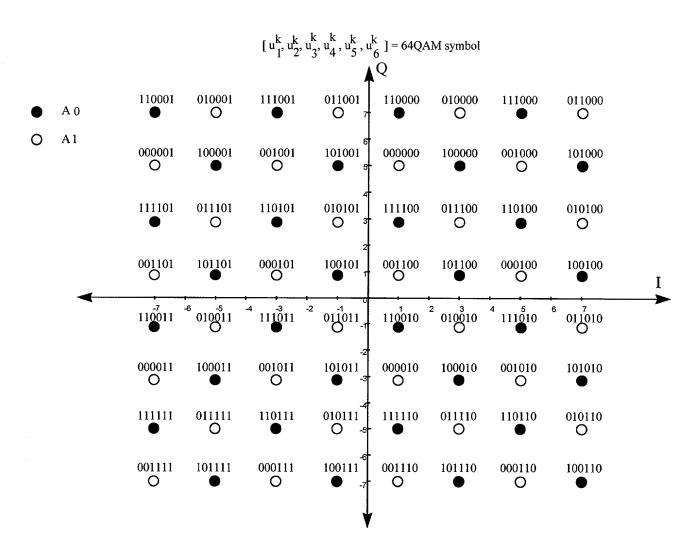


Figure 41

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT. . Attorney: Ronald Coslick - 042159 0119 Foley & Lardner - (310) 277-2223 Sheet 38 of 73

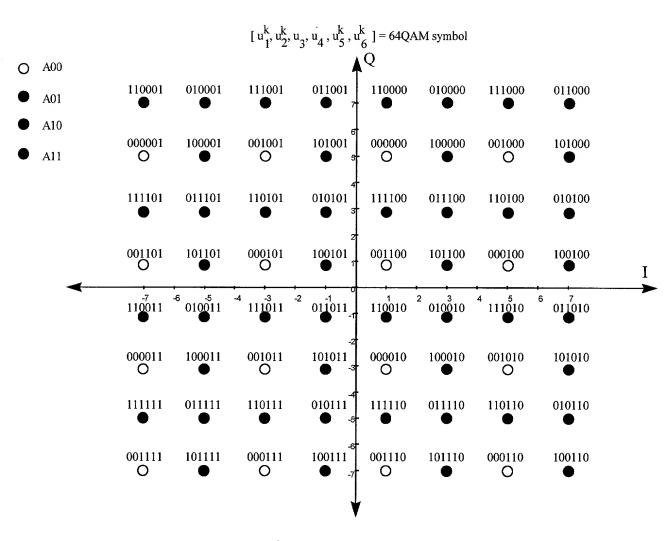


Figure 42

U.S Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT... Attorney: Ronald Coshck - 042159.0119

Foley & Lardner - (310) 277-2223

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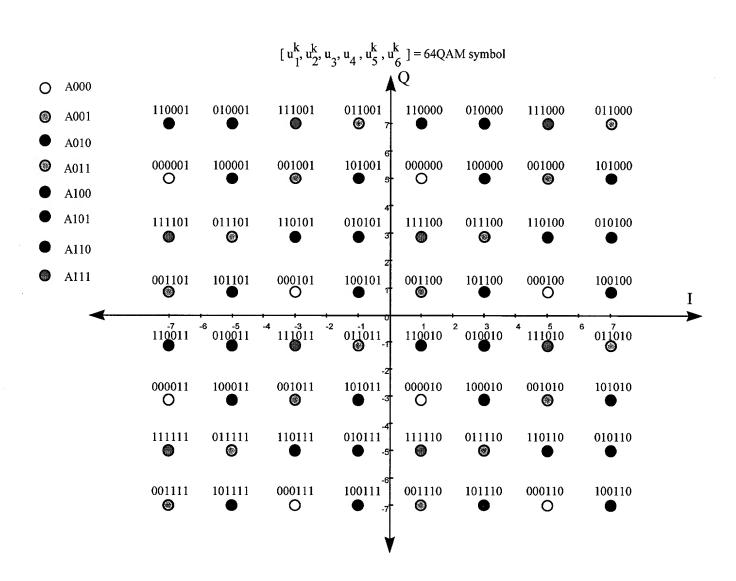


Figure 43

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT . Attorney Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223 Sheet 40 of 73

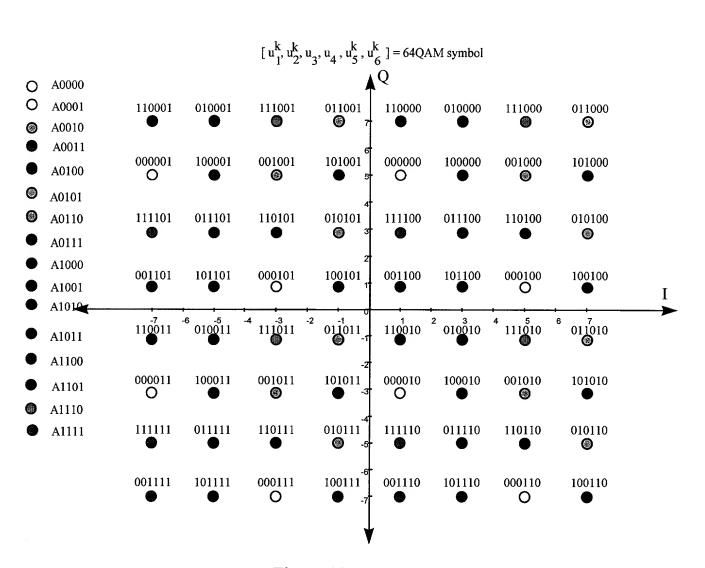


Figure 44

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT .. Attorney Ronald Coslick - 042159 0119 Foley & Lardner - (310) 277-2223 Sheet 41 of 73

#### BER for Rate 4/6 64QAM N=4,096 bits AWGN Channel

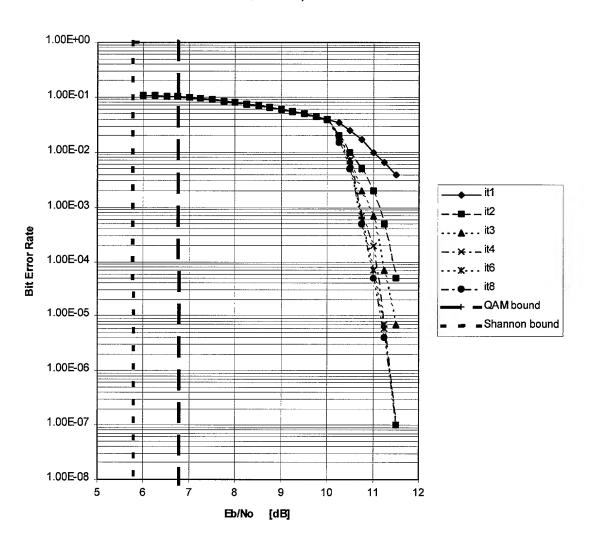


Figure 45

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT Attorney: Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223 Sheet 42 of 73

#### BER for Rate 5/6 64QAM N=5,120 bits AWGN Channel

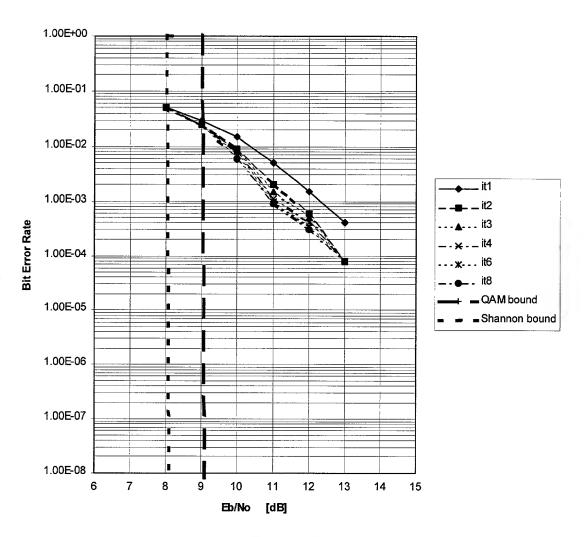


Figure 46

U.S Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT .. Attorney. Ronald Coslick - 042159 0119 Foley & Lardner - (310) 277-2223 Sheet 43 of 73

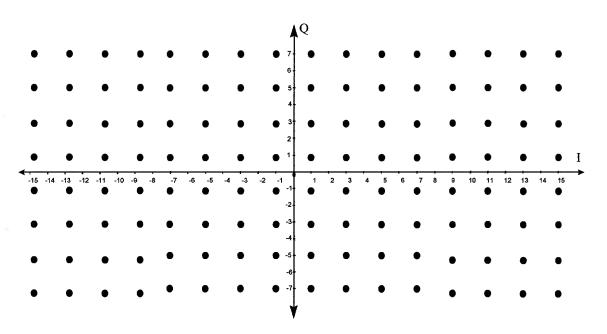
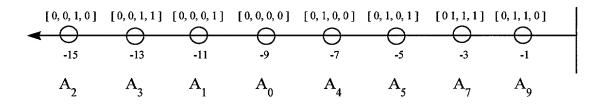


Figure 47



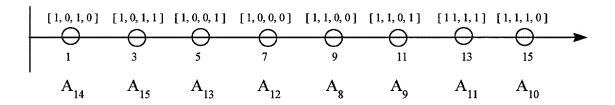


Figure 48

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT... Attorney Ronald Coslick - 042159 0119 Foley & Lardner - (310) 277-2223 Sheet 44 of 73

BER for Rate 5/7 128QAM N=5,120 bits AWGN Channel

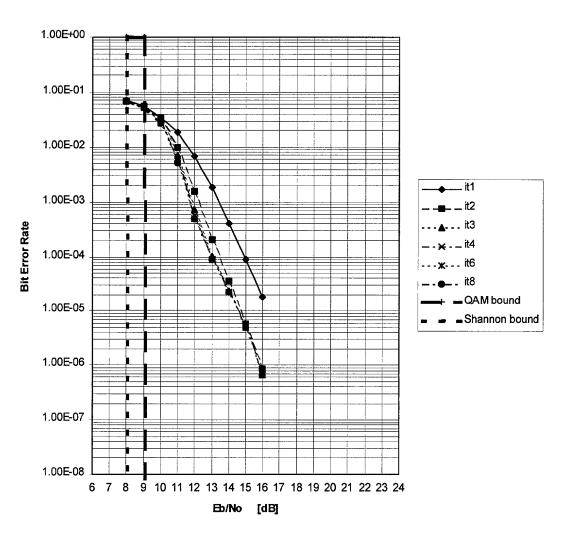


Figure 49

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT Attorney Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223 Sheet 45 of 73

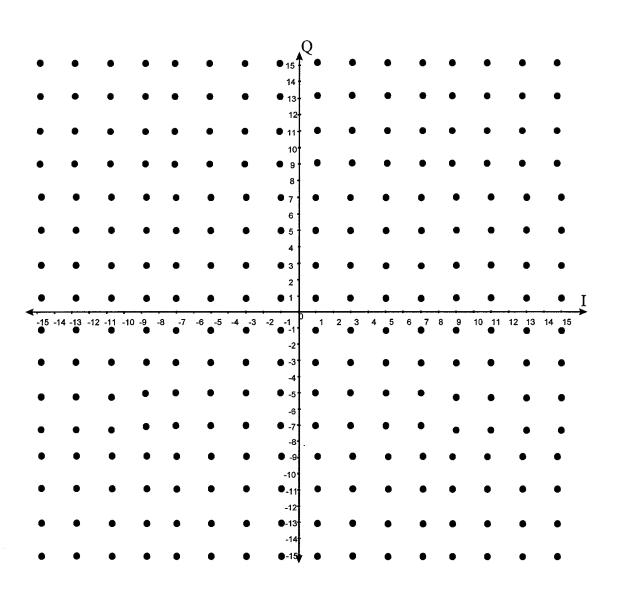


Figure 50

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT . Attorney: Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223

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#### BER for Rate 5/8 256QAM N=5,120 bits AWGN Channel

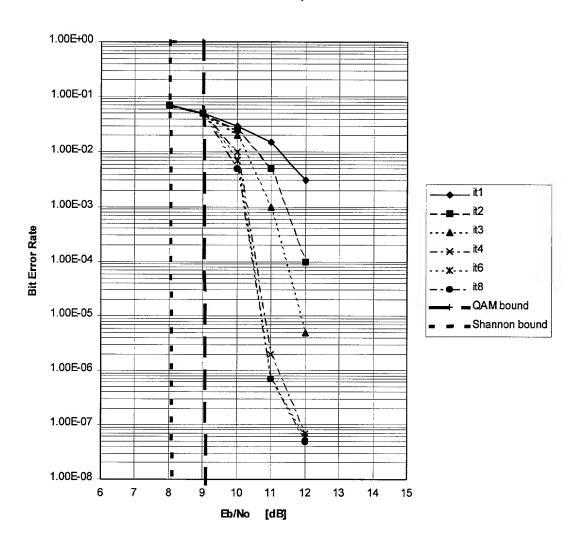


Figure 51

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT . Attorney. Ronald Coshck - 042159 0119 Foley & Lardner - (310) 277-2223 Sheet 47 of 73

#### BER for Rate 6/8 256QAM N=6,144 bits AWGN Channel

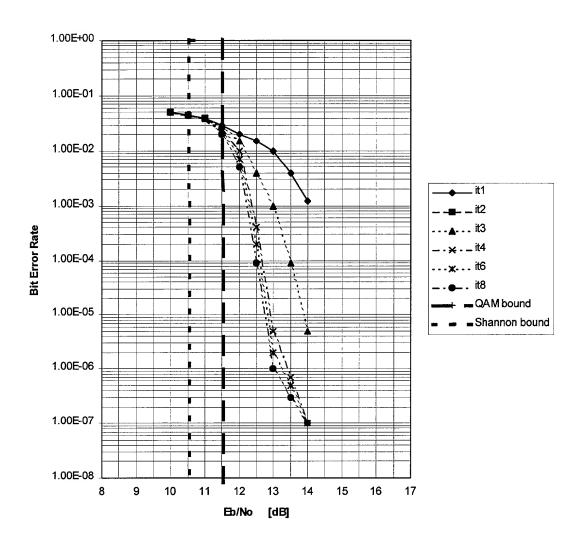


Figure 52

U S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT... Attorney Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223 Sheet 48 of 73

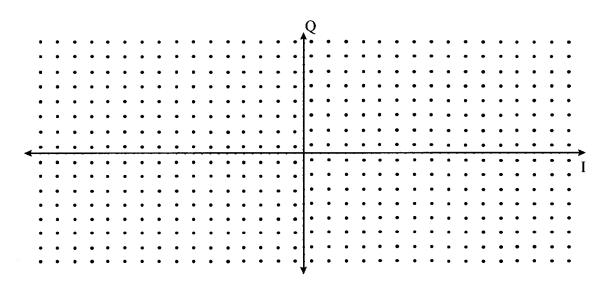


Figure 53

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT .. Attorney: Ronald Coshek - 042159 0119 Foley & Lardner - (310) 277-2223 Sheet 49 of 73

#### BER for Rate 6/9 512QAM N=6,144 bits AWGN Channel

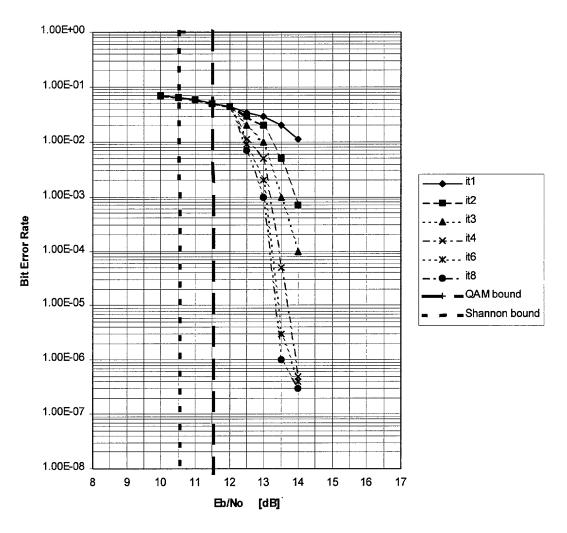


Figure 54

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT. Attorney Ronald Coslick - 042159 0119 Foley & Lardner - (310) 277-2223 Sheet 50 of 73

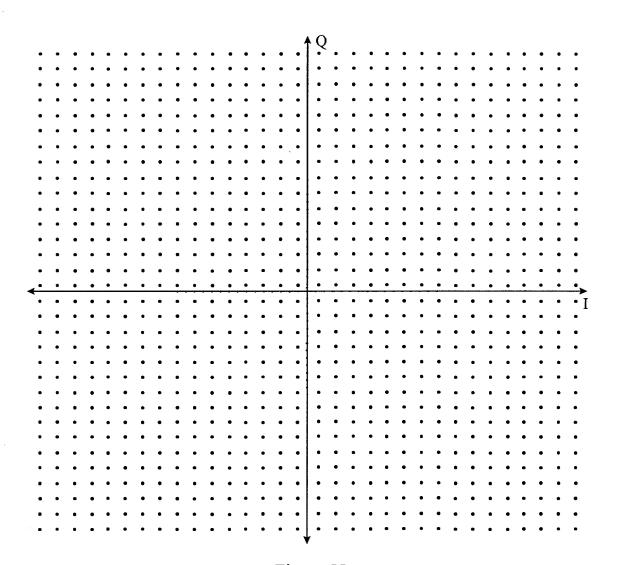


Figure 55

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT... Attorney: Ronald Coslick - 042159.0119

Foley & Lardner - (310) 277-2223

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#### BER for Rate 7/10 1024QAM N=2,044 bits AWGN Channel

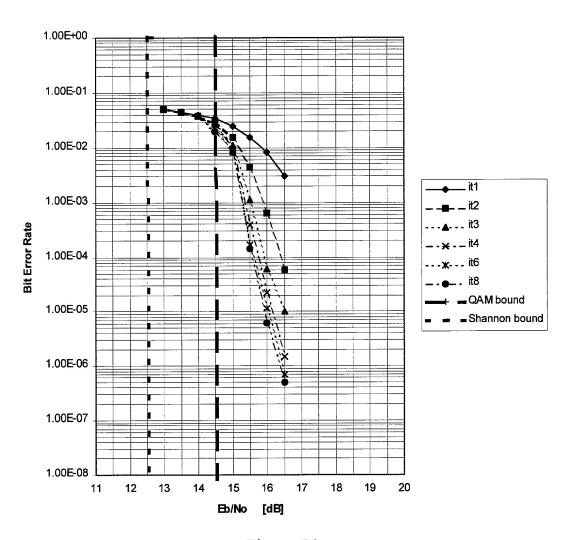


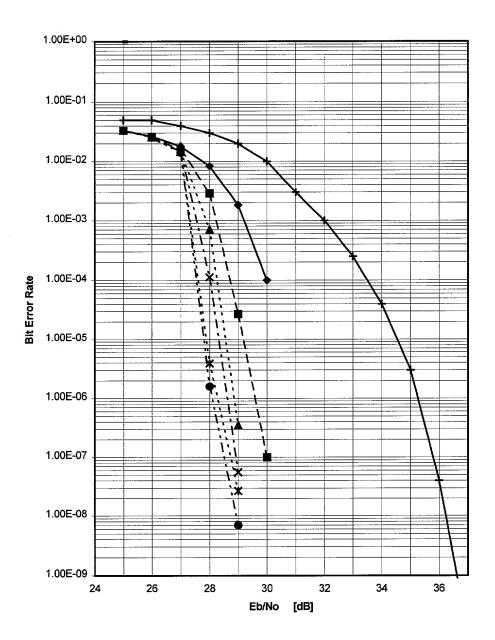
Figure 56

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BER for Rate 12/14 16384QAM N=31200 bits AWGN Channel



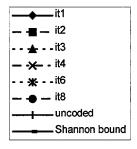


Figure 57

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT... Attorney: Ronald Coslick - 042159 0119 Foley & Lardner - (310) 277-2223 Sheet 53 of 73

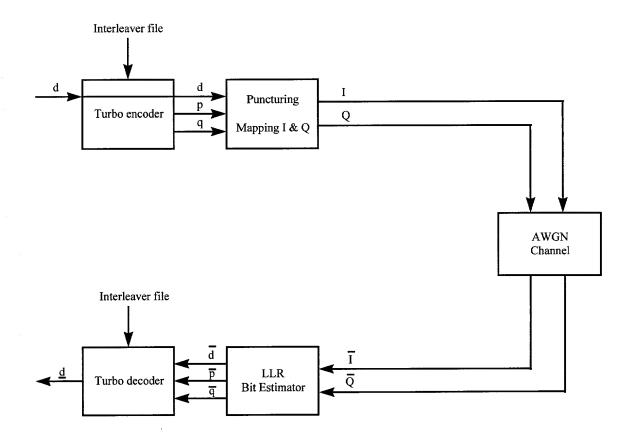
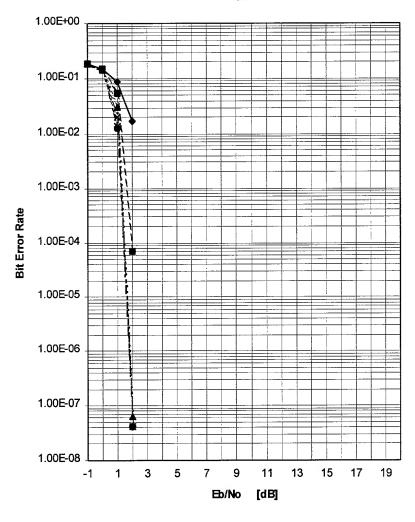


Figure 58

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT. . Attorney: Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223 Sheet 54 of 73

### BER for Rate 2/4 4QAM N=2,048 bits AWGN Channel S-type interleaver

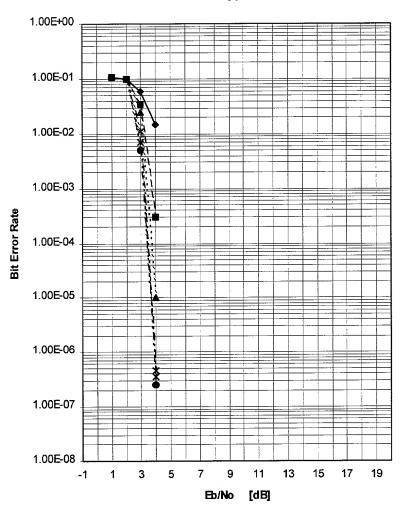


it1
<b></b> it2
<b>_</b> it3
×it4
<b>x</b> it6
it8

Figure 59

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT... Attorney: Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223 Sheet 55 of 73

## BER for Rate 2/4 16QAM N=2,048 bits AWGN Channel S-type interleaver



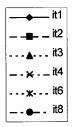
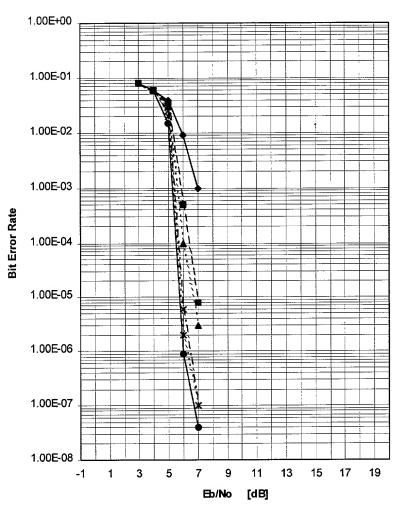


Figure 60

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT... Attorney Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223 Sheet 56 of 73

### BER for Rate 3/4 16QAM N=2,048 bits AWGN Channel S-type interleaver



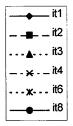
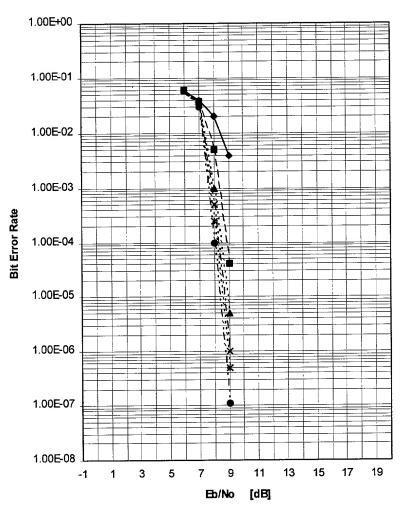


Figure 61

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT... Attorney Ronald Coslick - 042159 0119 Foley & Lardner - (310) 277-2223 Sheet 57 of 73

# BER for Rate 4/6 64QAM N=2,048 bits AWGN Channel S-type interleaver



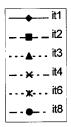
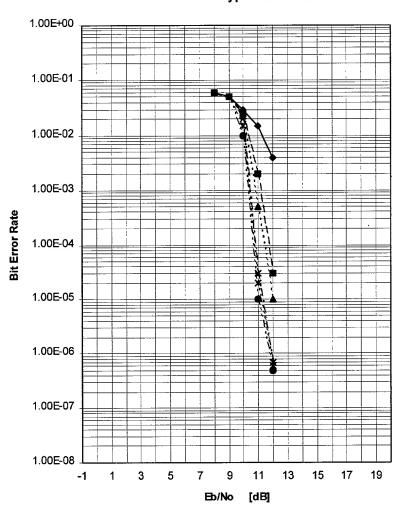


Figure 62

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT . Attorney. Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223 Sheet 58 of 73

### BER for Rate 5/8 256QAM N=2,048 bits AWGN Channel S-type interleaver



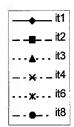
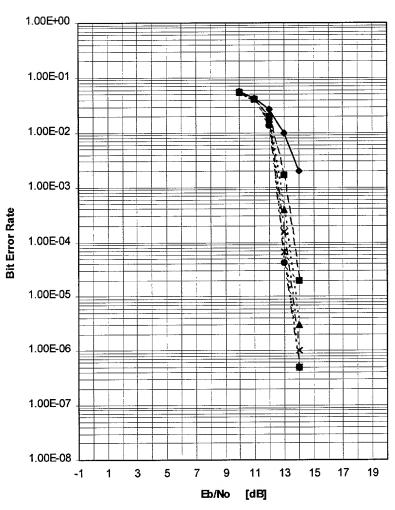


Figure 63

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT. . Attorney: Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223

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### BER for Rate 6/8 256QAM N=2,046 bits AWGN Channel S-type interleaver



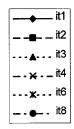
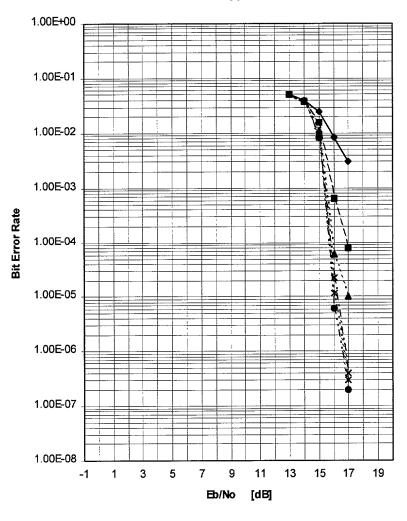


Figure 64

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT. . Attorney Ronald Coslick - 042159.0119 Foley & Lardnet - (310) 277-2223 Sheet 60 of 73

### BER for Rate 7/10 1024QAM N=2,044 bits AWGN Channel S-type interleaver



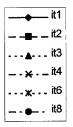
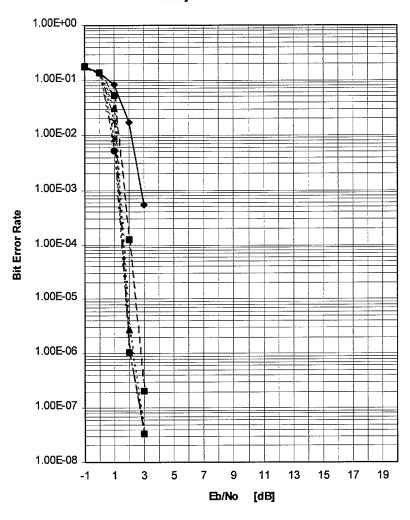


Figure 65

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT.. Attorney: Ronald Coslick - 042159 0119 Foley & Lardner - (310) 277-2223 Sheet 61 of 73

DED for Date 2/4 40 AM N=2 400 bits AWCN Channe

### BER for Rate 2/4 4QAM N=2,100 bits AWGN Channel Analytical odd-even smile interleaver



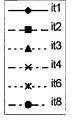


Figure 66

U.S. Express Mail No EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT. Attorney: Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223 Sheet 62 of 73

# BER for Rate 2/4 16QAM N=2,100 bits AWGN Channel Analytical odd-even smile interleaver

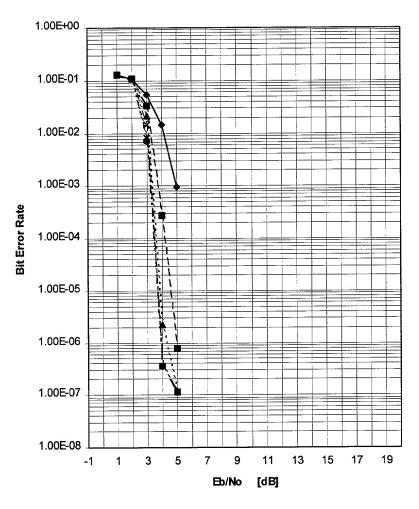


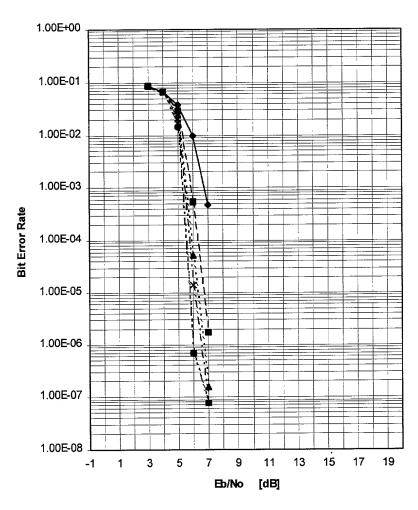


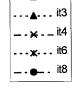
Figure 67

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT Attorney: Ronald Coslick - 042159 0119 Foley & Lardner - (310) 277-2223

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#### BER for Rate 3/4 16QAM N=2,100 bits AWGN Channel Analytical odd-even smile interleaver





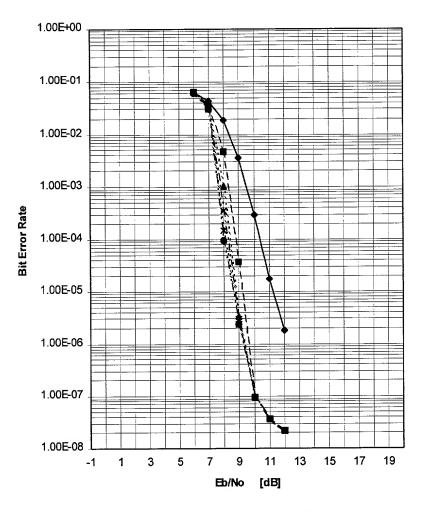
\_ it1

\_\_\_\_ it2

Figure 68

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT... Attorney: Ronald Coslick - 042159 0119 Foley & Lardner - (310) 277-2223 Sheet 64 of 73

## BER for Rate 4/6 64QAM N=2,100 bits AWGN Channel Analytical odd-even smile interleaver



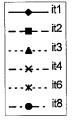
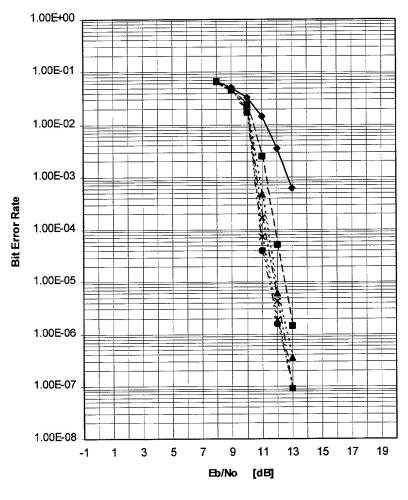


Figure 69

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT Attorney: Ronald Coslick - 042159 0119 Foley & Lardner - (310) 277-2223 Sheet 65 of 73

# BER for Rate 5/8 256QAM N=2,100 bits AWGN Channel Analytical odd-even smile interleaver



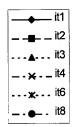
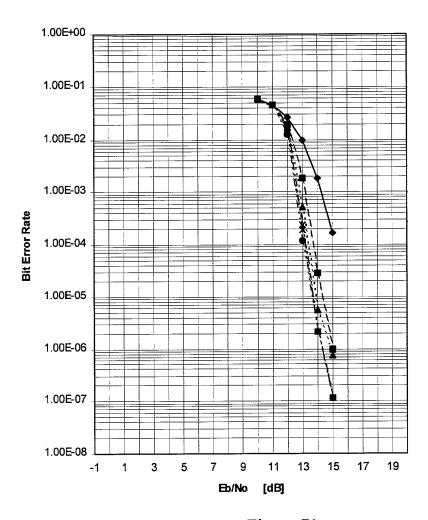


Figure 70

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT Attorney: Ronald Coslick - 042159 0119 Foley & Lardner - (310) 277-2223

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### BER for Rate 6/8 256QAM N=2,100 bits AWGN Channel Analytical odd-even smile interleaver



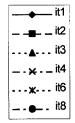
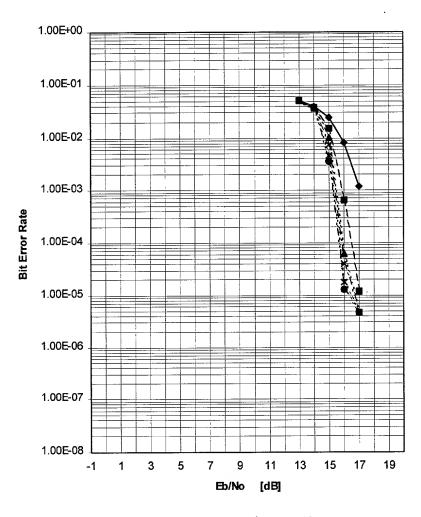


Figure 71

U.S. Express Mail No. EL.639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT. . Attorney. Ronald Coslick - 042159.0119 Foley & Lardner - (310) 277-2223 Sheet 67 of 73

## BER for Rate 7/10 1024QAM N=2,100 bits AWGN Channel Analytical odd-even smile interleaver



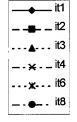


Figure 72

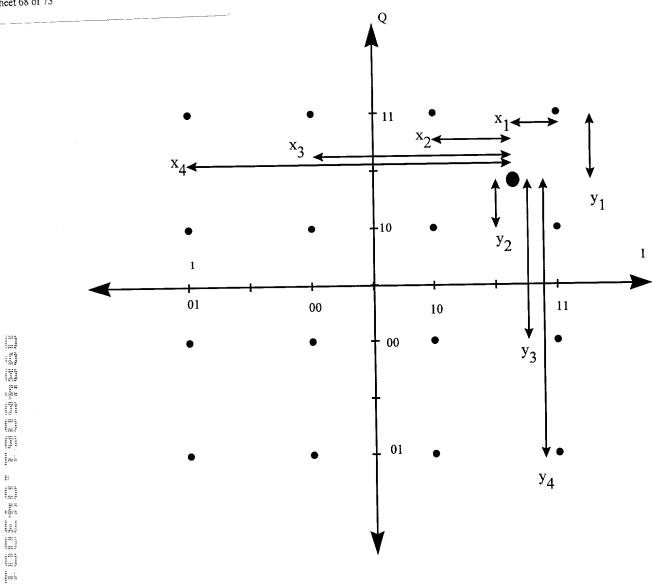


Figure 73

U.S. Express Mail No. EL639069986US USE OF TURBO-LIKE CODES FOR QAM MODULATION USING INDEPENDENT. Attorney Ronald Coslick - 042159 0119 Foley & Lardner - (310) 277-2223 Sheet 69 of 73

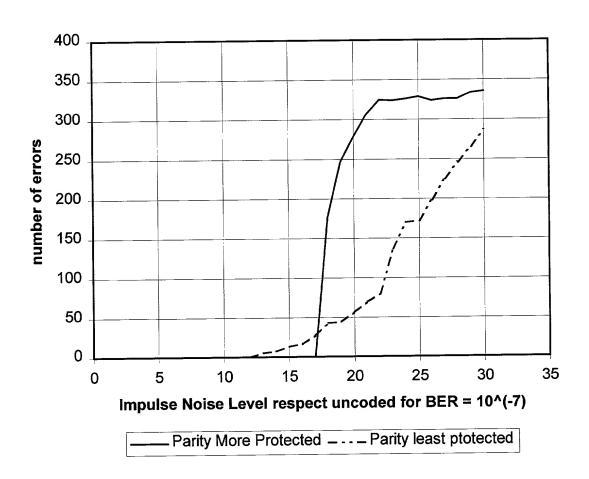


Figure 74

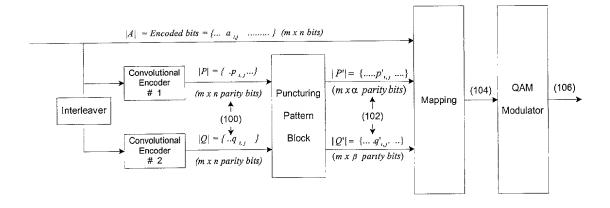


Figure 75

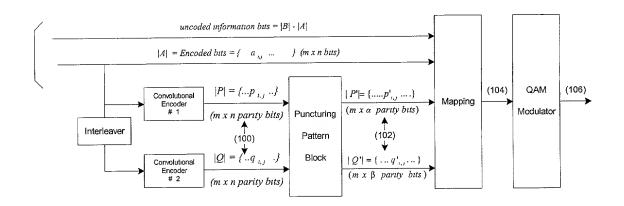


Figure 76

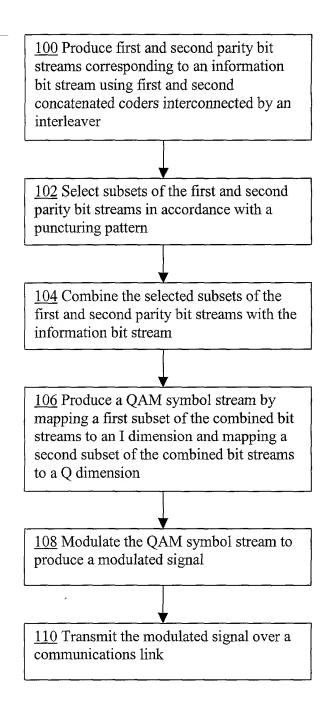


Figure 77

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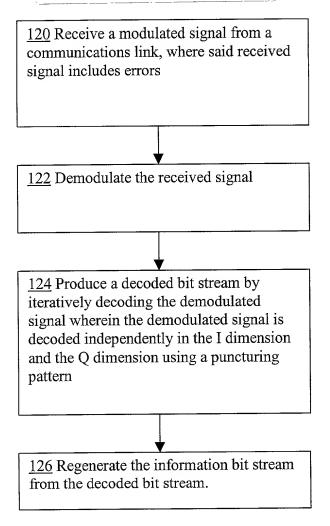


Figure 78

130 Receive a QAM symbol stream from a transmitter of the communication system

132 Determine a performance metric of the communication system based on the received QAM symbol stream

134 Determine a new puncturing pattern for use in the transmitter to improve the performance of the communication system

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136 Communicate the puncturing pattern to the transmitter

based on the performance metric

Figure 79